

## **LINEAR TRACKING COLUMN MODULE WITH PEDAL ASSEMBLY**

### **CROSS-REFERENCES TO RELATED APPLICATIONS**

[0001] This Application claims the benefit of United States Provisional Patent Application No. 60/473,787 filed on May 28, 2003, and United States Provisional Patent Application No. 60/444,297 filed on January 31, 2003.

### **FIELD OF THE INVENTION**

[0002] The subject invention relates to a vehicle steering assembly having components movable in response to a crash condition.

### **BACKGROUND OF THE INVENTION**

[0003] Adjustable steering column assemblies are well known in the art. Such assemblies typically include an energy-absorbing bracket or other support affixed to the body of a vehicle. Steering column components including, but not limited to a steering wheel and shaft are carried by the support. Should a collision occur in which a sufficiently large impact force is applied to the steering wheel, the steering column and wheel will collapse relative to the support and translate away from the driver of the vehicle.

[0004] Steering column and pedal assemblies exist which are designed to absorb forces other than those applied to the steering wheel of a vehicle. Such assemblies include those in which the foot pedals are mounted on the vehicle support structure independently of the mounting of the steering column, and where the pedals collapse under an applied collapse load in a crash event. An object of the present invention is to improve upon and simplify the manufacturing of collapsible column and pedal assemblies.

## SUMMARY OF THE INVENTION AND ADVANTAGES

**[0005]** The present invention provides a collapsible steering assembly including a steering mechanism and at least one foot pedal that is moveable in operation between a fully retracted position and a fully depressed position. A support structure connects the pedal or pedals to the steering mechanism to define a unitized module. The support structure supports the steering mechanism for collapsing movement in response to a predetermined collapse force on the steering mechanism. The support structure further supports the pedal or pedals for collapsing along a predetermined collapse path beyond the fully depressed position in response to application of another predetermined collapse force to the pedal or pedals.

**[0006]** Accordingly, the subject invention overcomes the limitations of the related art by providing a collapsible steering column assembly which utilizes guide rods to interconnect a steering assembly and pedal assembly with a single support structure to create a unitized module which may then be transported unit to an end user and installed as a single unit on a vehicle. The guide rods are capable of collective movement for permitting the steering assembly and pedal assembly to not only simultaneously translate relative to the support, but also independently move with respect to one another and to the support. The pedal assembly is mounted on the support structure in a manner that permits the pedal assembly to travel along a collapse path that is non-parallel to the longitudinal axis of the steering assembly.

**[0007]** The subject invention also includes a knee bolster interconnected by the guide rods to the support structure. The guide rods are distributed into two groups, with one group carrying the knee bolster and the other carrying the steering assembly. This permits independent movement of the knee bolster, pedal assembly and steering assembly relative to one another. The guides are also oriented to allow the knee bolster and steering assemblies to translate in directions other than those parallel to the longitudinal axis of the steering

assembly. In particular, the guides translate in directions corresponding to the typical trajectory paths of the upper torso and knees of a driver in a collision, which maximizes the energy absorbed by the assembly. The guides are also spaced to provide enhanced stability to the support, which minimizes the likelihood of accidental collapse of any one of the components of the assembly.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Other advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0009] Figure 1 is a perspective view of a collapsible steering column assembly according to one embodiment of the present invention installed on a vehicle subassembly;

[0010] Figure 2 is a perspective view of a steering column assembly according to Figure 1 prior to installation on a vehicle subassembly and prior to a collision event;

[0011] Figure 3 is a perspective view of the steering column assembly shown in Figure 2 after a collision event, with the steering assembly and knee bolster in respective collapsed positions and the lever arm removed;

[0012] Figure 4 is a cross-sectional view of one of the first anvil-strap devices utilized in the steering column assembly shown in Figures 1 through 3;

[0013] Figure 5 is a cross-sectional view of a pivot assembly utilized in an alternative embodiment of the invention for pivotally connecting a bolster tube to the knee bolster;

[0014] Figure 6 is an exploded perspective view of the knee bolster, bolster tubes and selected components associated therewith of the embodiment of the invention shown in Figures 1 through 3;

[0015] Figure 7 is an exploded perspective view of the knee bolster and lower and upper blocks illustrating the manner in which the lower block is connected to the upper block;

[0016] Figure 8 is a partial perspective view of the upper block and pairs of high-force and low-force straps of one of the second anvil-strap devices utilized in the steering column assembly shown in Figures 1 through 3;

[0017] Figure 9 is a partial cross-sectional view of a pair of pyrotechnic devices and pyrotechnic pins utilized in the second anvil-strap device;

[0018] Figure 10 is an exploded perspective view of the support, rear bracket and other selected components of the collapsible steering column assembly shown in Figures 1 through 3;

[0019] Figure 11 is an exploded perspective view of a steering column assembly according to Figure 2 and utilizing an alternative pedal assembly; and

[0020] Figure 12 is an exploded perspective view of the steering column mounting bracket and selected components of the pedal assembly shown in Figure 11.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Referring to the Figures, wherein like numerals indicate like or corresponding parts throughout the several views, a collapsible steering assembly is generally shown at **20** in Figures 1 through 14. The assembly **20** includes a steering mechanism **22** and at least one and preferably two foot pedals shown generally at **24**. The pedals **24** are movable in operation between a fully retracted position “P<sub>1</sub>” and a fully depressed position “P<sub>2</sub>” for actuating an operating system in a vehicle **26**.

[0022] A support structure **28** connects the pedals **24** to the steering mechanism **22** to define a unitized module operant from any support structure of the vehicle to which the assembly will be mounted. The support structure **28** supports the steering mechanism **22** for collapsing movement in response to application of a predetermined collapse force to the steering mechanism **22**. The support structure **28** also supports each pedal **24** for collapsing along a predetermined collapse path **30** beyond the fully depressed position “P<sub>2</sub>” in response to application of a predetermined collapse force **32** to the pedal **24**. Figure 3 shows the pedals **24** collapsed beyond the fully depressed position. Each pedal **24** is collapsible independently of the steering mechanism **22**. As is described in greater detail below, one pedal **24** is a brake pedal **34**. The other pedal **24** is a throttle pedal **36**.

[0023] The steering mechanism **22** has a longitudinal steering axis **38** that extends transversely to the predetermined collapse path **30**. A plurality of steering guide rods **40** are arranged about a common collapse axis **42** in non-parallel relationship to the steering axis **38**. The steering guide rods **40** interconnect the brake pedal **34** with the support structure **28** and guide movement of the brake pedal **34** along the predetermined collapse path **30** beyond the fully depressed position “P<sub>2</sub>” in response to application of the predetermined collapse force to the brake pedal **34**. The steering guide rods **40** also interconnect the pedals **24** and the steering mechanism **22**.

[0024] The steering mechanism **22** includes a steering shaft **44** extending coaxially with the steering axis **38** between upper and lower ends **46** and **48**, respectively. An upper bearing housing **50** and a rake bracket **52** are coaxially disposed about the steering shaft **44** adjacent the upper end **46**. A lower bearing housing **54** is coaxially disposed about the steering shaft **44** adjacent the lower end **48**. An alternative rake bracket **56** having a curved outer edge is shown in Figure 11.

[0025] Although the steering mechanism 22 of the present invention is a steering column assembly, those skilled in the art will appreciate that the steering mechanism 22 used in the assembly 20 need not be limited to one utilizing a traditional, mechanical linkage column structure. The steering mechanism 22 may comprise, for example, an electric steer-by-wire system which may or may not include a mechanical shaft 44.

[0026] Steering shear elements 58 interconnect the steering guide rods 40 and the support structure 28. The steering shear elements 58 prevent the steering mechanism 22 from moving relative to the support structure 28, and shear in response to application of the predetermined collapse force on the steering mechanism 22, which in turn allows the steering guide rods 40 and the steering mechanism 22 to move relative to the support structure 28.

[0027] The steering guide rods 40 are fixed relative to one another, which permits collective movement of the guide rods 40 relative to the support structure 28. Although each of the steering guide rods 40 may have any suitable shape, each guide rod 40 of the embodiments of the present invention is straight and comprises a tube having a front end 60 and a rear end 62. Although any number of steering guide rods, or tubes, 40 may be utilized and arranged in any suitable configuration relative to the support structure 28, four of such steering tubes 40 are preferably spaced from one another in a quadrangle.

[0028] The support structure 28 includes a front bracket 64 that interconnects the front ends 60 of the steering tubes 40. A rear bracket 66 supports the rear ends 62 of the steering tubes 40 and the steering mechanism 22. The front and rear brackets 64 and 66 are spaced on opposite sides of an intermediate bracket 68. The rear ends 62 of the steering tubes 40 extend through the rear bracket 66.

[0029] A second plurality of steering shear elements 58 interconnects the rear bracket 66 and the steering tubes 40. The steering shear elements 58 normally prevent movement of

the steering tubes 40 relative to the rear bracket 66, but shear in response to the predetermined force for allowing the steering tubes 40 to move through the rear bracket 66.

[0030] The assembly 20 also includes a knee bolster 70 coupled to the support structure 28. A plurality of bolster guide rods 72 are arranged about a second collapse axis 74 and interconnect the intermediate bracket 68 and said knee bolster 70. The bolster guide rods 72 support the knee bolster 70 for axial movement along the second collapse axis 74 in response to application of a second predetermined collapse force to the knee bolster 70. A plurality of bolster shear elements 76 interconnect the bolster guide rods 72 and the intermediate bracket 68. The intermediate bracket 68 supports the bolster guide rods 70 in fixed relationship to one another. The shear elements 76 prevent movement of the knee bolster 70 relative to the intermediate bracket 68 and shear in response to application of the second predetermined collapse force to the knee bolster 70. This allows the bolster guide rods 72 and the knee bolster 70 to move relative to the intermediate bracket 68.

[0031] While each of the bolster guide rods 72 may have any suitable shape, each guide rod 72 is a straight tube that has a front end 78 and a rear end 80. Any number of bolster guide rods, or tubes, 72 may be utilized and arranged in any suitable configuration relative to the support structure 28. The assembly 20 includes four of the bolster tubes 72. The tubes 72 are spaced from one another in a quadrangle. The knee bolster 70 is connected to the front ends 78 of the bolster tubes 72, and the rear bracket 66 supports the rear ends 80, which in turns spaces the knee bolster 70 and the rear bracket 66 from and on opposite sides of the intermediate bracket 68.

[0032] While any appropriate shearable device may be used, the steering shear elements 58 and bolster shear elements 76 of the present invention preferably comprise bushings. Each bushing surrounds one of the tubes 40 or 72 and engages one of either the

intermediate bracket 68 or the rear bracket 66. Each bushing also has a detent or other feature which maintains the tube 40 or 72 in a fixed position relative to the intermediate bracket 68 or rear bracket 66 during normal operation. The detents or other features on the bushings maintaining the linkage between the intermediate bracket 68 or the rear bracket 66 and the respective tubes 40 or 72 will be broken, or “shear”, upon application of a sufficient collapse force to the steering mechanism 22 or the knee bolster 70. This overcomes the holding force on the tubes 40 or 72 and releases the tubes 40 or 72 for movement relative to the intermediate bracket 68 or rear bracket 66.

[0033] The front bracket 64 includes a central opening 82 and a peripheral edge 84 from which a collar 86 extends. A collar 86 having an alternative shape is shown in Figure 11. The upper end 46 of the steering shaft 44, the upper bearing housing 50, and the rake bracket 52 extend through the opening 82. The lower end 48 of the steering shaft 44 extends beyond the rear bracket 66, whereby the front bracket 64, intermediate bracket 68 and rear bracket 66 are spaced along the steering shaft 44 between the upper and lower ends 46 and 48.

[0034] A rake assembly is generally shown at 88. The rake assembly 88 interconnects the rake bracket 52 with the front bracket 64 and permits selective pivotal movement of the steering shaft 44 relative to the intermediate bracket 68 and front bracket 64. The rake assembly 88 includes an adjustment mechanism 90 disposed against the front bracket 64 and engaging the steering shaft 44 for moving the steering shaft 44 relative to the opening 82. A spring 92 interconnects tabs 94 extending from the rake bracket 52 and front bracket 64 for supporting the steering shaft 44 at a preselected rake angle ( $\alpha$ ) relative to the steering tubes 40. The collar 86 has a slot 96 through which a complementary nut and bolt

assembly **98** extends for interconnecting the adjustment mechanism **90** with the steering shaft **44** and maintaining the shaft **44** at the preselected rake angle ( $\alpha$ ).

[0035] The rear bracket **66** includes at least one and preferably two connectors **100** for attachment to the vehicle **26**. The intermediate bracket **68** likewise includes at least one and preferably two connectors **100** for attachment to the vehicle **26**. Each connector **100** has a hole **102** extending therethrough for receiving a complementary bolt (not shown) to permit attachment to the vehicle **26**. As is best shown in Figure 7, the intermediate bracket **68** includes an upper block **104** having bores **106** therethrough. The steering tubes **40** extend through the bores **106**. The intermediate bracket **68** also includes a lower block **108** having bores **110** therethrough. The bolster tubes **72** extend through the bores **110** in the lower block **108**.

[0036] The steering tubes **40** of the assembly **20** include an upper pair and a lower pair. A steering mechanism support bracket **112** interconnects the lower pair and supports the steering mechanism **22**. The steering mechanism support bracket **112** has spaced arms **114** with bores **116** extending therethrough. The lower bearing housing **54** extends between the arms **106**. Pivot pins **118** are received within the bores **116** for pivotally connecting the lower bearing housing **54** to the steering mechanism support bracket **112**, which permits pivotal movement of the steering mechanism **22** relative to the steering mechanism support bracket **112**.

[0037] The assembly **20** of the present invention also includes at least one and preferably two beams **120** which interconnect the upper block **104** and the rear bracket **66** to prevent relative movement therebetween. The upper block **104** and rear bracket **66** include slots **122**. The beams **120** have opposed ends **124** that are received within the slots **122**.

[0038] Referring specifically to Figure 7, the manner in which the lower block 108 is connected to the upper block 104 is shown. The lower block 108 includes spaced bracket segments 126 through which the bores 110 extend. The bracket segments 126 are interconnected by a web 130 having threaded bores 132 extending therethrough. The upper block 104 includes complementary threaded bores 134, which are aligned with the bores 132. Threaded fasteners 136 are received within respective pairs of the aligned bores 132 and 134 for connecting the lower block 108 to the upper block 104.

[0039] The bolster tubes 72 of the assembly 20 are disposed in at least one pair on either side of the steering tubes 40. The bolster tubes 72 are also disposed transversely to the steering tubes 40. Two pairs of bolster tubes 72 are preferred, and each pair extends through the bores 110 in a selected one of the bracket segments 126.

[0040] Disposing the bolster tubes 72 outside the steering tubes 40 permits the knee bolster 70 to collapse without interfering with or otherwise initiating a simultaneous or subsequent collapse of the steering tubes 40 and steering mechanism 22. Positioning the bolster tubes 72 at a transverse angle to the steering tubes 40 orients the stroke path of the knee bolster 70 at an angle complementary to the normal trajectory of the knees of a vehicle operator or a passenger as the knees impact and simultaneously translate with the bolster 70 along the second collapse axis 74 in response to application of the second predetermined force on the bolster 70.

[0041] One of two connective clamps 138 interconnects the rear ends 80 of each pair of bolster tubes 72. The knee bolster 70 is supported by the front ends 78 of both pairs of bolster tubes 72. Referring specifically to Figure 6, an annular ridge 140 on each of the front ends 78 is disposed in engagement with one of a plurality of annular rims 142 disposed on the bolster 70.

[0042] As is shown in Figure 5, the front end 78 of each bolster tube 72 may alternatively be connected to the bolster 70 using one of a plurality of pivot assemblies 144. Each pivot assembly 144 includes a collar 146 defining a concave pivot surface 148. A shank 150 extends from the end 78 to an end sphere 152. The sphere 152 is captured within the collar 146 and pivots relative to the surface 148.

[0043] The knee bolster 26 is preferably fabricated from a deformable material such as metal and, as such, is deformable upon impact with the knees of a vehicle operator. The pivot assemblies 144 accommodate the deformation and bending forces imparted to the bolster 70 during such an impact by pivoting to allow the bolster 70 to bend relative to the tubes 72 without imparting a bending moment to the tubes 72. The forces normally applied to the bolster 70 are instead applied in the axial direction of the tubes 72.

[0044] Each clamp 138 extends between opposed cylindrical ends 154 having openings 156 within which the rear ends 80 are received. As is shown in Figure 6, the clamp 138 includes holes 160 adjacent each end 154. Complementary fasteners 162 are received within the holes 160 for securing the adjacent cylindrical end 154 about the rear end 158.

[0045] Although the knee bolster 70 is a single panel, the bolster 70 may alternatively be bifurcated to form a panel having left and right sections capable of independent movement relative to one another. The bolster 70 and components associated therewith may alternatively be adapted for use on the passenger side of the vehicle 26 or in any other passenger seating area within the vehicle 26.

[0046] The assembly 20 also includes an energy absorber system 164 for absorbing movement of the steering mechanism 22 and pedals 24 respectively relative to the intermediate bracket 68. The energy absorber system 164 of the assembly 20 also includes at least one and preferably two first anvil-strap devices generally shown at 166. Each anvil-

strap device **166** interconnects a selected one of the clamps **138** with the lower block **108**. The anvil-strap devices **166** absorb energy upon movement of the bolster tubes **72** through the lower block **108** in response to the second predetermined collapse force.

[0047] Referring again to Figure 6, each anvil-strap device **166** includes a housing **168** disposed against one of the bracket segments **126**. Each bracket segment **126** has a central opening **170** interposed between spaced holes **172**. The housing **168** includes spaced connectors **174** which are received within the holes **172** for securing the housing **168** against the bracket segment **126**.

[0048] As is shown in Figure 4, an anvil block **176** has at least one and preferably two oppositely arranged anvils **178** and **180** disposed within the housing **168**. The anvils **178** and **180** are spaced from one another in one of two preselected positions to define one of two tortuous pathways **182** and **184**. A plastically deformable strap **186** having opposed ends **188** extends through the housing **168** along the first tortuous pathway **182** in frictional and bending engagement with the anvils **178** and **180**. One end **188** is secured to the clamp **138** by a nut and bolt assembly **164**. This permits the strap **186** to be pulled through the housing **168** along the first pathway **182** and simultaneously drawn against the anvils **178** and **180** for absorbing a controlled amount of energy as the bolster tubes **72** move relative to the lower block **108**.

[0049] The anvil-strap device **166** also includes a pyrotechnic assembly **190** for selectively controlling the amount of energy absorbed by the strap **186**. The pyrotechnic assembly **190** is carried by the housing **168** and communicates with an external control system **192**. The control system **192** functions to position the anvil **178** in a selected one of the pathways **182**, **184** dependent upon one or more variable conditions existing prior to or during the crash condition.

[0050] Each pyrotechnic assembly 190 includes at least one explosive pin 194 that extends through the anvil 178. A pyrotechnic actuator 196 is carried by the housing 168 and communicates with the pin 194. The actuator 196 is selectively actuated by the control system 192 to cause the pin 194 to explode or otherwise be effectively removed from the anvil 178. This permits lateral movement of the anvil 178 and creates the second tortuous pathway 184.

[0051] Although the anvil-strap devices 166 of the assembly 20 are variable energy absorbing systems that utilize S-straps, one skilled in the art will appreciate that other energy absorbing devices may be used, including but not limited to those which employ one or more M-straps, J-straps, other straps, wires, pyrotechnic or other actuating devices, or a combination thereof.

[0052] The energy absorber system 164 of the assembly 20 also includes a second anvil-strap device, which is generally shown at 198 in Figure 1. The second anvil-strap device 198 interconnects the steering tubes 40 and upper block 104. As is shown in Figure 2, the second anvil-strap device 198 includes a release bracket 200. The release bracket 200 has bores therethrough and is disposed in engagement with the intermediate bracket 68 in the absence of the predetermined collapse force of the steering mechanism 22. The steering tubes 40 extend through the bores and are carried by the release bracket 200 in fixed relation to one another. Referring now to Figure 8, at least one, or as disclosed, two pairs of plastically-deformable straps 204 with holes 206 therethrough are disposed in frictional engagement with respective pairs of first and second anvils 208 and 210. The straps 204 interconnect the release bracket 200 with the intermediate bracket 68. Each pair 204 includes a high-force strap 212 and a low-force strap 214 extending in parallel relation to one another from the release bracket 200. As is shown in Figures 2 and 3, retaining pins 218 are disposed

within the release bracket **220**. Each pin **218** extends through one of the holes **206** and interconnects the associated strap **212** or **214** with the release bracket **200**. The pins **218** may alternatively be disposed within the upper block **104** for securing the straps **212** and **214** with the upper block **104** (not shown).

[0053] Like the first anvil-strap devices **166**, the second anvil-strap devices **198** are variable energy absorbing systems. However, the second anvil-strap devices **198** utilize pairs of S-straps having variable widths. One skilled in the art will appreciate that other energy absorbing devices may be used, including but not limited to those which employ one or more M-straps, J-straps, other straps, wires, pyrotechnic or other actuating devices, or a combination thereof.

[0054] A hinge assembly **220** extends from the release bracket **200**. The hinge assembly **220** may be used for attaching an optional display screen or other control device (not shown) to the assembly **20**.

[0055] Referring specifically to Figure 9, the second anvil strap device **198** also includes actuating devices **222**, which are disposed upon threaded bosses **224** that extend from the release bracket **200**. Each device **222** engages one of the pins **194** and selectively discharges for actuating movement of the pin **194** to a discharged position. This alters the frictional force generated by the strap **212** or **214** associated with the pin **194** as the strap **212** or **214** moves across the anvils **208** and **210** shown in Figure 8. Each pair of anvils **208** and **210** displaces a portion of the pair of straps **212** and **214** associated therewith and imposes a reaction force thereon to absorb energy as the straps **212** and **214** move past the anvils **208** and **210**. The anvil-strap device **198** is shown in Figure 3 after discharge of the devices **222** and following collapse of the steering assembly **22**.

[0056] Although any suitable actuating device may be utilized, each actuating device 222 is preferably an electrically activated pyrotechnic device. A control system such as that which is schematically depicted at 192 in Figure 4 is operatively connected to the devices 222, monitors and detects variable components affected by the crash condition, determines the amount of energy to be absorbed, and transmits a signal corresponding to that amount to the actuating devices 222, which in turn actuates or more of the devices 222. For example, during a crash condition in which a large predetermined force is applied to the assembly 20, none of the actuating devices 222 will be discharged in order to maximize the frictional forces between the pairs of straps 204 and the anvils 208 and 210, which in turn maximizes the amount of energy absorbed. The actuating devices 222 will initiate release of the low-force straps 214 in response to a moderate predetermined force on the assembly 20. The actuating devices 222 will respond to a low predetermined force on the assembly 20 by initiating release of the high-force straps 212.

[0057] The assembly 20 may also use an alternative energy absorbing device, which is generally shown at 224 in Figures 10 and 11. The device 224 includes a single pair of high-force straps 226. A release bracket 228 releasably engages the intermediate bracket 68. The release bracket 228 includes bores 230 through which the steering tubes 40 extend in fixed relation to one another, and opposed sides 232 from which shear tabs 234 extend. A pair of pyrotechnic bosses 236 are disposed between the tabs 234 and bores 230. The release bracket 228 also has a pair of elongate chambers 238 extending therethrough in communication with the bosses 236.

[0058] The intermediate bracket 68 includes notches 238 in which the tabs 234 are disposed. Shear pins 239 interconnect each tab 234 and notch 238 for shearing in response to the predetermined collapse force to release the release bracket 228 from the intermediate

bracket 68. The intermediate bracket 68 also has a slot 240 intermediate the bores 106. As is shown in Figure 10, the strap guide 242 is disposed within the slot 240. Pyrotechnic pins 244 are disposed within the notches 238 and connect the straps 226 to the release bracket 228. The straps 226 extend from the pins 244 through the strap guide 242. Actuation devices 246 identical to the actuation devices 222 are disposed within the bosses 236 and are operatively connected to a control system like the control system 192 shown in Figure 4. The pins 244 are selectively actuated by the actuation devices 246 to selectively control the rate of energy absorption by the straps 226 as the release bracket 228 moves away from the intermediate bracket 68.

[0059] Referring again to Figures 2 and 3, the assembly 20 also includes a pedal assembly, which is generally shown at 248. The pedal assembly 248 carries the pedals 24 or, as disclosed, the brake pedal 34 and throttle pedal 36. The pedal assembly 248 is also disposed against the steering guide rods, or tubes, 40 for movement relative the support structure 12 in response to application of the predetermined collapse force to the steering mechanism 22. Specifically, the pedal assembly 248 is pivotally connected to the rear bracket 66 for pivotal movement in response to movement of the steering tubes 40 relative thereto.

[0060] The pedal assembly 248 is an adjustable pedal assembly. A mounting assembly 250 carries the pedals 24 and a hinge assembly 252 interconnects the mounting assembly 250 and the support structure 12 for permitting pivotal movement of the pedals 24 relative to the support structure 12. In particular, the hinge assembly 252 interconnects the mounting assembly 250 to the rear bracket 66.

[0061] The brake pedal 36 is part of a brake assembly 254. The brake assembly 254 includes a first bracket 256 that interconnects the brake pedal 34 and the mounting assembly

**250.** The first bracket **256** includes spaced slots **258**. Adjustment fasteners **260** adjustably mount the brake pedal **34** in the slots **258** for permitting movement of the brake pedal **34** relative to the first bracket **256**.

**[0062]** The throttle pedal **36** is part of a throttle assembly **262**. A second bracket **264** having spaced slots **266** interconnects the throttle pedal **36** and the mounting assembly **250**. Adjustment fasteners **268** adjustably mount the throttle pedal **36** in the slots **266** for adjusting the throttle pedal **36** relative to the second bracket **264**.

**[0063]** The hinge assembly **252** features a bifurcated bracket **270** that carries the mounting assembly **250**. The bifurcated bracket **270** has spaced openings **272** through which the rear ends **62** of two of the steering tubes **40** extend. A joint **274** is interposed between the openings **272** and extends between two nut and bolt assemblies **276**. A hinge **278** is pivotally connects the bifurcated bracket **270** to the rear bracket **66**, which permits pivotal movement of the mounting assembly **250** relative to the rear bracket **66**.

**[0064]** Rather than utilizing the mounting assembly **250** and hinge assembly **252**, the pedal assembly **248** may alternatively include a mounting assembly **280** and hinge assembly **282** such as those shown in Figures 10 and 11. In contrast to the mounting assembly **250**, the mounting assembly **280** includes a U-shaped plate **284** having at least one nut and bolt assembly **286** extending therethrough for securing the brake and throttle assemblies **254** and **262** to the plate **284**. An intermediate bracket **288** is disposed against the plate **284** and has holes **290** extending therethrough.

**[0065]** As is shown in Figures 11 and 12, the hinge assembly **282** includes a bracket **292** with spaced openings **294** through which the rear ends of two of the steering tubes **40** extend. The bracket **292** also has holes **296** aligned with the holes **290**. A threaded bolt **298** extends through each pair of the holes **290**, **296** for securing the intermediate bracket **288** to

the bracket 292. A hinge device 300 connected together by a complementary hinge pin 302 interconnects the bracket 292 and rear bracket 66 together for permitting pivotal movement of the pedal assembly 248 relative to the rear bracket 66.

[0066] Referring now to Figures 12 and 13, the energy absorber system 164 also includes a shear strap mechanism 304 interconnecting the mounting assembly 280 and the rear bracket 66. The shear strap mechanism 304 includes a pyrotechnic housing 306 disposed between the openings 294 of the bracket 292. An actuating device 308 and a pedal shear pin 310 are disposed within the housing 306. The pedal shear pin 310 is held in position by a shear pin retaining clip 314. The rear bracket 66 includes a slot 316. A strap guide 318 is disposed within the slot 316. A plastically deformable strap 320 extends through the strap guide 318. The strap 320 has holes 322 therethrough. Energy-absorbing tapping screws 324 extend through the holes 322 and connect the strap 320 to the bracket 292 and rear bracket 66.

[0067] Although any suitable actuating device may be utilized, the actuating device 308 preferably comprises a gas generating pyrotechnic device. A control system such as that which is schematically depicted at 192 in Figure 4 is operatively connected to the device 308. The control system monitors and detects variable components affected by the crash condition, determines the amount of energy to be absorbed, and transmits a signal corresponding to that amount to the actuating device 308, which in turn actuates the device 308. Furthermore, although a single plastically-deformable strap 320 is used in combination with a strap guide 318 to absorb energy, one skilled in the art will appreciate that other energy absorbing devices may be used, including but not limited to those which employ one or more M-straps, J-straps, other straps, wires, or a combination thereof.

[0068] The strap 320 maintains the bracket 292 in a stationary position relative to the rear bracket 66 in the absence of the predetermined collapse force 23 or 32. However, upon application of the predetermined collapse force on the steering mechanism 22 or the pedals 24, respectively, the actuating device 308 will "fire" or otherwise actuate and apply a downwardly directed force on the shear pin 310. This causes the retaining clip 314 to loosen, which in turn releases the shear pin 310. The pin 310 strikes and cuts the shear strap 320 apart, which frees the bracket 292 and permits pivotal movement of the pedal assembly 248 relative to the rear bracket 66. The strap 320 is pulled through the strap guide 318 and absorbs energy as the freed assembly 248 pivots relative to the rear bracket 66.

[0069] While the invention has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.